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Cc: anita_bilbao@blm.gov[anita_bilbao@blm.gov]; Brian Mueller[bmueller@blm.gov]
From: Betenson, Matthew
Sent: 2017-08-30T16:10:11-04:00
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Subject: Re: GSENM Requested Maps
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GSENM Proclamation Objects Highlights 08.2017.docx

Ed,

Attached is a summary of some of the new research related to GSENM Objects since designation.

Also, I feel we can offer a little more information about the landscape feature data that is being used on the maps. I can work with Brian on it if you like.

I hope you find the information useful and please let me know if you need anything else.

On Tue, Aug 29, 2017 at 8:47 AM, Edwin Roberson <eroberso@blm.gov> wrote:

Matt, I wanted to share the maps i sent back to D.C. As my note indicates, We will be overlaying the data themes on one map. Ed

Sent from my iPhone

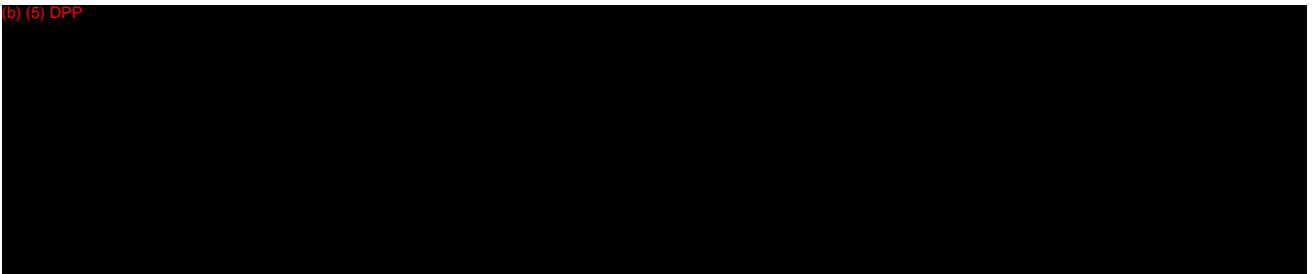
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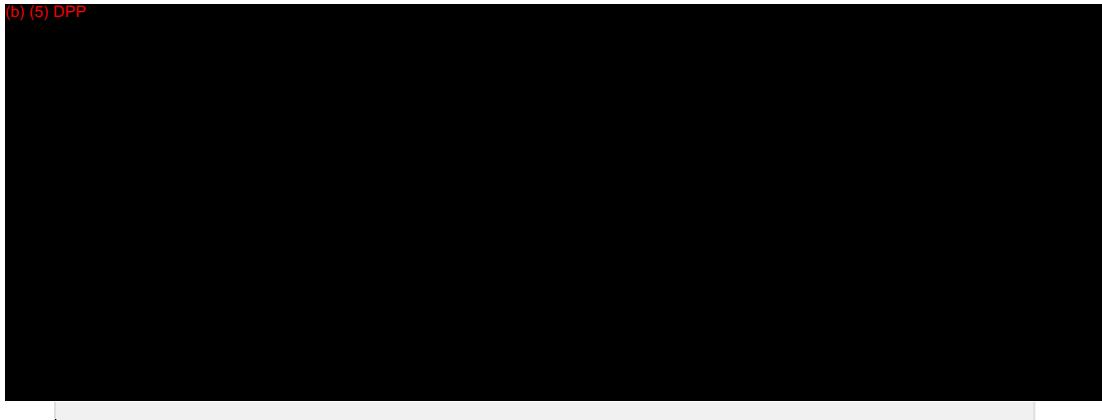
From: "Roberson, Edwin" <eroberso@blm.gov>

Subject: Fwd: GSENM Requested Maps

Here are maps with some of the individual data layers you were looking for. The first is Wilderness Study Areas. The second is Lands with Wilderness Character. There is still some project related LWC inventory work being done in the southwest portion of the monument so it will change. The last two maps show oil and gas and coal leases at the time the monument was established. We are will get mineral potential information tomorrow. The last map shows polygons depicting the landscape features/objects listed in the proclamation. Here are the objects/features.

(b) (5) DPP





When we get the mineral info we can produce a map with all four layers you requested. ed

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Highlighted Objects & Research

Understanding the History of Humans In the Region

Hole-in-the-Rock Trail - Significant site in Utah History associated with the 1879-1880 mission that took the first permanent settlers to San Juan County from many southern Utah communities. The trail and associated road building is likely one of the best examples of pioneer spirit including ingenuity, tenacity, and courage. The site is listed on the National Register of Historic Places (in 1980). A 2017 Ethnographic Landscape Report was prepared by NPS leading towards considering the trail and its associated places (such as Hole-in-the-Rock, Dance Hall Rock, and the many temporary camps) as a Traditional Cultural Property.

Dance Hall Rock – A large natural bedrock exposure that is a major landmark along the Hole-in-the-Rock Trail. This location was used by the Hole-in-the-Rock expedition as a social focal point during the construction of the trail through Hole-in-the-Rock and down to the Colorado River. Dances were held at this location during this period in 1879-1880 while pioneers were camped a mile away at Forty Mile Spring. There are numerous inscriptions of the members of the expedition carved into this landform.

Old Paria Townsite – While early settlement occurred in the region from 1869-1885, people lived in the area until the mid-1930s. The landscape today is relatively unchanged from modern development. The major alteration of the landscape is a result of the flooding of the Paria River through the years. This helps illustrate the history of the area and why settlement failed.

Southern Paiute and Navajo Peoples – Used this area extensively and have reservations near by. In 1934 Isabel Kelly wrote a Southern Paiute ethnography of the area describing Southern Paiute lifeways in this area including areas around Kanab, Kitchen Corral Canyon, and the Kaiparowits. This publication has been a guiding reference for current graduate student research in ethnobotany and Native American spring/water use on the Monument. Southern Paiute people still use many places on the Monument for collection of natural resources. There is some use of the area by Navajo peoples including a 1860s camp in vicinity of White House Campground. This general area, including Catstair Canyon is still used as by Navajo peoples for plant collection.

Mormon Exploration and Settlement - Important to the settlement of this area and to Utah history, there are numerous homesteads, ranches, and early settlements located on the Monument and in the surrounding area. Additionally, there are a number of wagon trails and early automobile trails connecting these places as well as line camps, cattle trails, corrals, cabins, rock houses, and other manifestations related to the early livestock grazing that occurred in association with settlement.

Historic Trails, Inscriptions – Hole-in-the-Rock Trail (see above) is listed on the National Register of Historic Places. The Old Spanish Trail is a National Historic Trail that roughly parallels Hwy 89 on the Grand Staircase. Many other trails, including the Boulder Mail Trail from Escalante to Boulder and Old Paria Road from Johnson Canyon to Paria River, are associated with Mormon exploration and settlement.

Opportunities for Archaeological Research – Academic research has occurred in this area since perhaps around 1890. University of Utah did a lot of research on the Kaiparowits and Escalante Canyons area associated with the construction of Glen Canyon Dam in the 1950s and 60s.

Steward did early research in the Anasazi area of the Vermillion Cliffs in the 1930s. BYU has done a lot of research in the Escalante Region in the late 1990s and early 2000s. Current graduate research within the past 5 years has included paleoecological analysis of the both the Grand Staircase and Kaiparowits regions, rock art research, and ethnobotanical studies. Research potential and opportunities are of plenty.

Fremont-Anasazi Occupation – Fremont occupation occurred along the Escalante River corridor and Potato Valley (Escalante area) and continued onto the Kaiparowits and Aquarius Plateaus from 300 BC to circa 1300 AD. Anasazi occupations (500 BC to 1300 AD) occurred on the Grand Staircase along the Vermillion Cliffs and up canyons (Johnson Canyon, Kitchen Corral Canyon, Paria River, Wahweap Creek, etc) as well as certain places on the Kaiparowits Plateau. Interactions between the Fremont and the Anasazi occurred on the Kaiparowits Plateau (particularly Fifty Mile mountain and the Straight Cliffs areas and Escalante Canyon, and probably also around Wahweap Creek (more research needs to be done). Fremont and especially Anasazi had large populations of people living in this area particularly from 900 AD to 1300 AD.

Geologic Structures, Stratigraphy, and Erosional Features

The Grand Staircase (Paleozoic) -- An unbroken, well-exposed, sequence of cliffs and plateaus of through Tertiary sedimentary rocks that rise 5,500 feet from the Chocolate Cliffs to the rim of Bryce Canyon. *"The most colorful exposed geologic section in the world."* - H.H. Doelling. This physiographic region was the centerpiece of classic geological studies by Powell, Stanton, Dutton, Walcott, Thompson, and others and has become symbolic of early geologic exploration on the Colorado Plateau (Titus, 2013). The Vermilion Cliffs in particular contain a rich Late Triassic-through early Jurassic fossil record deposited on the eastern shores of ancient Lake Dixie. Petrified wood, fish remains, dinosaur and other reptilian bones and fossil footprints are common (Fox and Joyce, 2007?). One site in particular, the Flag Point tracksite (42KaNNNN) is probably worthy of world heritage designation as the fossil tracks are in direct association with a unique Native American rock art panel depicting dinosaur tracks. The area has become a popular ATV riding destination as it contains a segment of the Great Western Trail and also numerous trails along the Wygaret and Skutumpah terraces. Hiking is also popular in the particularly deep and long slot canyons hosted in the Navajo Sandstone such as Willis Creek, Bull Valley Gorge, and Lick Wash.

The Upper Paria Region – Rugged canyons, natural arches, and "hydrothermal-collapse" pipes and dikes. The Upper Paria River region contains more of the same geologic and scenic features found inside Kodachrome Basin State Park. The middle Jurassic rocks (Carmel and Entrada formations) exposed there are particularly colorful and varied. The collapse features are part of a fascinating story of geologic catastrophe, being triggered by either a massive earthquake or asteroid impact.

White Cliffs -- Exposure of more than 1,500 vertical feet of eolian (wind-deposited), Jurassic Navajo Sandstone. This formation is world renowned for its scenic beauty. It is actually the remains of the largest sand sea (erg) that ever existed and thus is geologically unique. However, the formation is widespread on the Colorado Plateau region and is the centerpiece of such scenic wonders such as Zion, Arches, and Capitol Reef national parks.

Vermilion Cliffs -- Jurassic Moenave and Kayenta Formations of near-shore marine origins. The Moenave and Kayenta formations are actually river, dune and lake deposits the accumulated far from any marine shoreline. The upper portion of this sequence is a common arch former and thus of scenic value, while the cliffs themselves are particularly scenic with their deep red hues. The layers date to the early Jurassic and record a major extinction and the ascendancy of the dinosaurs in North American ecosystems. The most common fossils are fossil footprints and invertebrate traces.

Kaiparowits Plateau – Cretaceous, coal-bearing deltaic sequences deposited in a major depositional basin. Part of the coal field is burning underground from naturally ignited fires. The Burning Hills are evidence of past fires. The vast, wild, rugged badlands scenery of the Kaiparowits Plateau is comparable to that of the famous Bisti Badlands of New Mexico, both in character and color, but with more topographic relief. Overall the region is characterized by gray colors and towering cliffs separating tiers of fossil-rich badlands (see below under Paleontological Resources). Coal resources are mostly confined to the eastern half, where the conditions were more persistently swampy. In these areas, coal fires such as are found in the Burning hills provide a rich veneer of red and orange color where the rocks have oxidized. Most of the formations locally weather into intricate scenic hoodoos. Several routes through the region such as the Smoky Mountain road, Collett Canyon, and Croton Canyon are popular with OHV users. The “otherworldly” scenery of the Kaiparowits is also popular with advertisers and film companies and several large budget movies such as “Planet of the Apes,” “John Carter of Mars,” “The Outlaw Josey Wales,” and “Evolution,” have been filmed in and around the Kaiparowits over the last four decades. Although typically not a “hiking destination” the ever increasingly popular Heyduke Trail now traverses the northern half of the Kaiparowits Plateau.

Straight Cliffs – These cliffs are a series of stacked, Cretaceous barrier islands. The Straight Cliffs are so named because the cliffs themselves mimic the Cretaceous shoreline. UPDATE: The Straight Cliffs topographic feature is formed in the Straight Cliffs Formation of Cretaceous age. The scenic cliffs are a prominent regional land form and define the eastern edge of the Kaiparowits Plateau. Some of the most significant archeology in the entire monument is found on its southern end.

The Cockscomb – An impressive, erosional “hogback” developed along the East Kaibab monocline. The East Kaibab monocline is the steeply dipping east limb of the Kaibab anticline. The Cockscomb is one of the Monument’s true scenic wonders. It is a large scale ridge formed by the resistant geologic layers caught up in the large scale folding of the East Kaibab Monocline, which continues into Arizona and defines the east edge of the Grand Canyon. The stark uplift, broad exposures of multicolored rocks and intricate canyons carved into it create a feature comparable in wonder and beauty to that of Capitol Reef National Park, Comb Ridge, or The San Rafael Swell. It is extremely popular with tourists, many of which drive the busy Cottonwood Canyon road. Popular destinations include the Paria Townsite and Josey Wales movie set, Hackberry Canyon, The Box, Cat Stair Canyon, The Squeeze, the Cottonwood Narrows (most accessible slot canyon in the Monument), Grosvenor Arch, The Gut, and the Brigham Plain road.

Circle Cliffs – A breached anticline which exposes sedimentary rocks of the Triassic Chinle and Moenkopi formations that contain large, unbroken petrified logs, uranium minerals, and bitumen deposits. The Circle Cliffs contains spectacular Colorado Plateau scenery of painted-desert badlands and sandstone cliffs. Numerous Cold War era uranium mines that were hosted in the Shinarump Member of the Chinle Formation are popular as tourist destinations. Hiking is popular in many of the canyons that lead into the Escalante River drainage. Rock climbing has become a popular activity on vertical exposures of the Wingate Sandstone, especially along Long Canyon on the Burr Trail.

Waterpocket Fold – A long, sinuous geologic fold and erosional expression, similar to The Cockscomb, comprising the east flank of the Circle Cliffs anticline. The Waterpocket Fold is the same exact feature found in Capitol Reef National Park, with which GSENM shares a common boundary. Its world class scenery and rugged remoteness are popular with wilderness seekers.

Natural Arches and Bridges – Escalante Natural Bridge, Grosvenor Arch, Starlight Arch, Woolsey Arch, Window Arch, Boyington Arch, Phipps Arch, Sunset Arch. The Monument’s arches and natural bridges, with Grosvenor Arch and those exposed along the Escalante River corridor are continually increasing in popularity as tourist destinations. Grosvenor is a rare double arch which towers over 150 feet high.

Canyon Exposures – Vivid colors of the Escalante Canyons region and elsewhere cause by intense erosion and downcutting (no opportunity for soil forming) of the many Mesozoic sedimentary rocks units. These exposures provide geologists with unobscured views of Earth history. The Escalante Canyons region is the single most visited area within GSENM. An abundance of slot canyons, towering cliffs, scenic red rocks, and lush riparian areas combine to make it one of the most beautiful and popular areas in the entire region. Recent geological studies in the area have sought to establish the rates of erosion, and the chemical and migration history of iron minerals that provide the color to the rocks (Chan and Beitler NNNN).

World-Class Paleontological Sites

Circle Cliffs – Unbroken petrified Jogs up to 30 feet in length are present in the Petrified Forest Member of the Chinle Formation. Survey work by Yale between 2002-2006 documented a number of important vertebrate fossil sites in the Chinle Formation in the Circle Cliffs region including a nearly complete articulated rare reptile called *Poposaurus* (<http://peabody.yale.edu/support/peabody-finds-poposaurus>). The region has not been the focus of much additional survey work since 2006 and numerous additional sites probably still await discovery.

Kaiparowits Plateau – One of the best, most continuous records of Late Cretaceous life in the world. Fossils include mollusks, reptiles (turtles, crocodilians, lizards), dinosaurs, fishes, and mammals. The Kaiparowits rocks contain the only evidence, in our hemisphere, of terrestrial vertebrate fauna from the Cenomanian through Santonian (Late Cretaceous) ages

The Cretaceous age fossil resources of the Kaiparowits Plateau have exceeded the Proclamation's expectations both in terms of abundance and scientific significance. Almost 4,000 new fossil sites have been documented by Museum and University crews under the coordination of the Monument's paleontology program since 2000. All formations have yielded vertebrate fossils, but Tropic Shale, Wahweap, and Kaiparowits fossils have been most spectacular and significant. Scientific work on these fossils has resulted in the publication of 12 new species of dinosaurs in the last 12 years, a pace on par with any other dinosaur producing region in North America. A Kaiparowits specific conference on late Cretaceous paleontology was held in 2009, which resulted in the publication of a 625 page book called "At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah" (Titus and Loewen, 2013). Because of its unique ancient geography and environments, the region remains the most complete, most fossiliferous Late Cretaceous terrestrial fossil record in the western hemisphere. They were also recently showcased during an international meeting on vertebrate paleontology held in Salt Lake City (Titus, Eaton, and Sertich, 2017).

The Cretaceous formations of the Kaiparowits Plateau are, in ascending order with their significance summarized:

- **Dakota Formation** – Important early mammal and reptile fossils. Contains one of the only terrestrial vertebrate fossil records in North America. The Bulldog Bench and Rimrocks (lower Cottonwood Canyon) areas are especially rich. Larger remains are rare, but intact turtle shells, and pieces of crocodiles are fairly common. Dinosaurs are still only known by tooth records. The mammal, fish, amphibian and lizard faunas were published in Titus and Loewen (2013). Surveys by Weber State and the Natural History Museum of Utah are ongoing.
- **Tropic Shale Formation** – Best marine reptile record from the southern Interior Seaway. Inventory work has shown that a truly remarkable marine reptile record is in the Tropic. Five species of plesiosaur (whale-size marine reptiles) and North America's oldest mosasaur

were found between 2000 and 2010. This is the highest diversity known for the period in North America. Many acres remain to be surveyed, particularly in the Croton Canyon and Steer Canyon areas.

- **Straight Cliffs Formation** – Tibbet Canyon member-The Tibbet Canyon has been intermittently surveyed in the southwestern portion of the Kaiparowits Plateau where it contains fossil sharks teeth, turtle shell and rare dinosaur remains. It is mostly marine in the eastern half of the Kaiparowits, where it lacks an abundance of vertebrate fossils. Spectacular logs of petrified wood occur east of Cottonwood Canyon. No new animals have been named from the unit.
- **Smoky Hollow and John Henry members** -Two small dinosaur bonebeds were found in the Smoky Hollow member in 2009 during survey work in the southwestern Kaiparowits Plateau. These are some of the only records of Turonian dinosaur skeletons in Utah. The John Henry member has yielded associated tyrannosaur material and other rare dinosaur finds in the same area. Dinosaur remains from the time of the John Henry Member are extremely rare throughout the whole world and any material is considered significant. No dinosaurs have been named from the Straight Cliffs formation thus far. The mammal, turtle, fish and lizard faunas of these two units was published in Titus and Loewen (2013).
- **Wahweap Formation** – The exact age of the Wahweap Formation was unknown when the Monument was established. Research has since shown that the unit dates to between 78 and 81 million years ago. The most fossiliferous part of the formation (middle shale member) has produced a spectacular dinosaur fauna that is older than similar faunas found in Montana and Canada (Titus, Eaton, and Sertich, 2017). In general, the western outcrops are more fossiliferous than those in the east. Five new species of dinosaurs (*Diabloceratops eatoni*, *Machairoceratops cronusi*, *Adelopholus hutchisoni*, *Aristavus gaglaroni*, *Lythronax argestes*) have been named, with two more and a giant crocodile currently being researched. A rich fossil record has yielded important specimens of everything from fish to mammals and plants (Titus and Loewen, 2013). It is one of the most complete known middle Campanian ecosystems preserved in North America and gives key insights into the evolution of later, more famous Campanian species. Survey work in the formation is still in its early stages, with only an estimated 10% of available exposures having been covered.
- **Kaiparowits Formation** – This formation has long been known to be the most fossiliferous formation in the region and it has been the focus of most recent survey work. New species of dinosaurs were discovered the very first field season (2000) by crews from the Natural History Museum of Utah and almost every year since. In total seven new species (*Hagryphus*, *Gryposaurus monumentensis*, *Nasutoceratops titusi*, *Kosmoceratops richardsoni*, *Utahceratops gettyi*, *Teratophoneus currie*, *Talos sampsoni*) have been published. A similar number will be published in the next few years, making it one of the most scientifically productive dinosaur resources in North America. Similar age beds in Canada have also provided a complete glimpse of this time period, but the Kaiparowits Formation is the most complete Late Campanian fossil ecosystem in the southern USA. Some of the literally world class finds include mass death assemblages of turtles, crocodiles and dinosaurs preserved with soft tissue and eggs; an entire tyrannosaur family killed by fire (only multi individual tyrannosaur site in the southern USA); an nearly complete articulated tyrannosaur (the only one ever found in the southern USA); and a fossil forest floor preserved with all of its plants in upright, 3D position. It is almost impossible to overstate the scientific importance of the this particular formation and its fossil content. Approximately 30% of the formation has been surveyed as of 2017.

Monument Wide – Although not specifically noted in the Proclamation, many opportunities for paleontological research also exist in formations of the Permian, Triassic, Jurassic, and Tertiary periods.

Opportunities for Biological Research and Discovery

Five Life Zones – The life zones range from low-lying desert to coniferous forests containing a blend of warm and cold desert floras. This rich floristic region contains a large number of endemic species. Because of its rugged remoteness, the Monument contains many isolated biologic communities (hanging gardens, tinajas, rock crevices, canyon bottoms, dunal packet communities).

Diverse Soils – An array of strata (parent material), exposed in many places, that give rise to diverse soils that support equally diverse plant communities and their pollinators. These communities offer opportunities to study plant speciation and community dynamics.

Relic Vegetation -- Isolated because of topography, many areas contain relatively undisturbed plant communities - some of which may have existed since the Pleistocene. No Mans Mesa is an example where pinyon-juniper communities contain trees as much as 1,400 years old.

Cryptobiotic Crusts -- These crusts contain unique microbiotic communities that stabilize the highly erodible soils of the region.

Packrat Middens -- Provide insight into climate and vegetation over the past 25,000 years.

Livestock Grazing – The Monument has partnered with Utah State University for livestock grazing research opportunities.

Wildlife Diversity – Besides mountain lion, black bear, mule deer, elk, and desert bighorn sheep, the Monument is home to over 200 species of birds. Wildlife concentrates mainly in the riparian zones of the Paria and Escalante River drainages.

Citations

Titus, A. L. and Loewen, M.A. 2013. At the top of the Grand Staircase, the Late Cretaceous of Southern Utah. Indiana University Press, Bloomington, 625 pages.

Titus, A.L., Eaton, J.G., and Sertich, J., 2016, Late Cretaceous stratigraphy and vertebrate faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, southern Utah: Geology of the Intermountain West, v. 3, p. 229–291.